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Scott G. Santarelli, Michelle H. Champion, James P. Kenney, *Robert J. Mailloux

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Antenna Technology Branch (AFRL/RYHA)
80 Scott Drive
Hanscom AFB, MA 01731-2909
*University of Massachusetts, Amherst, MA

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14. ABSTRACT

A previous mathematical analysis has demonstrated the utility of a partially overlapped, constrained-feed network for time-delay control of large linear arrays (R.J. Mailloux, IEEE Trans. 49, February 2001, pp.280-291). In particular, this novel method allows for approximately –30 dB sidelobe suppression over a 20% bandwidth. An array with time-delayed contiguous subarrays with the same separation would have quantization lobes at the –10 dB level; thus, this technique appears to offer significant advantages. We recently developed an experiment to demonstrate this concept. We collected data for the broadside case (array phase shifters set to zero) from –45° to 45° in 0.25° increments and from 9.0 to 11.0 GHz in 0.05 GHz increments (center frequency of 10 GHz). We allowed weighting of both the Rotman lens outputs (constituent beams) and the Butler matrix outputs (subarray patterns). We used a genetic algorithm to optimize these complex weightings. We realized that our data set didn't represent the best measure of system performance, since there is no beam squinting at broadside; therefore, we performed a limited field of view (LFOV) test. Using this LFOV test, we were able to demonstrate at least –28 dB sidelobes over an angular field of view corresponding to a 20% bandwidth.

15. SUBJECT TERMS
Constrained-feed network, overlapped subarray architecture, phased arrays

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Optimization of a Constrained-feed Rotman Lens Beamformer

20 October 2005

Scott G. Santarelli[(1)]

Michelle H. Champion[(1)]

James P. Kenney[(1)]

Robert J. Mailloux[(2)]

(1) Air Force Research Laboratory, Hanscom AFB, MA

(2) University of Massachusetts, Amherst, MA

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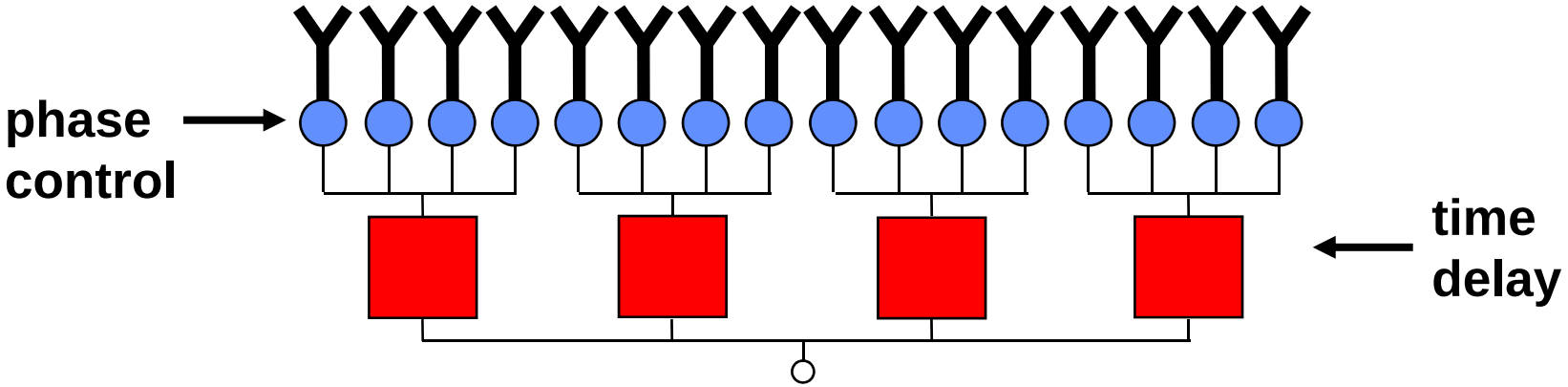
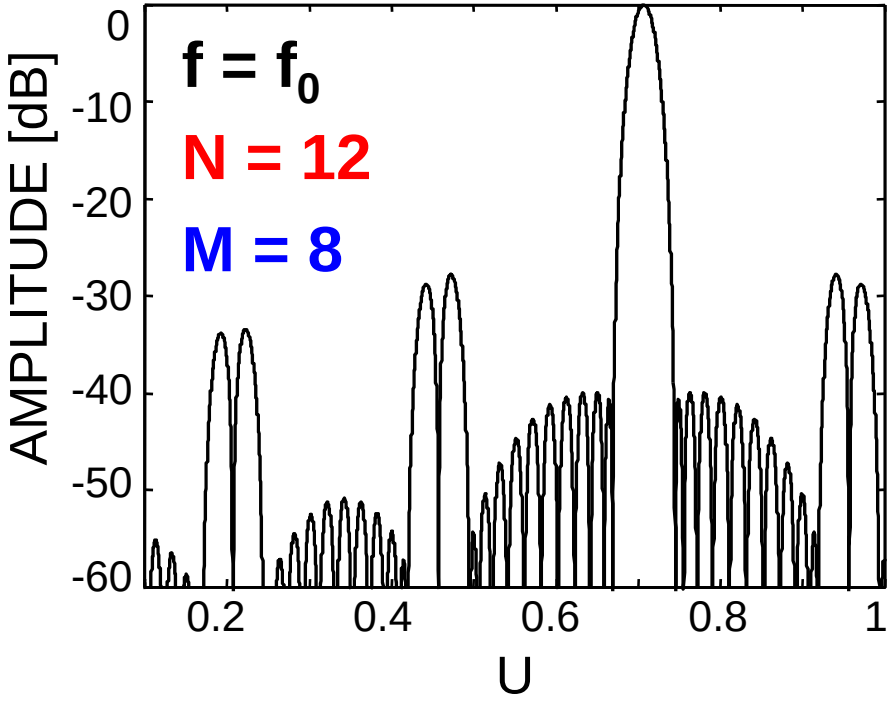
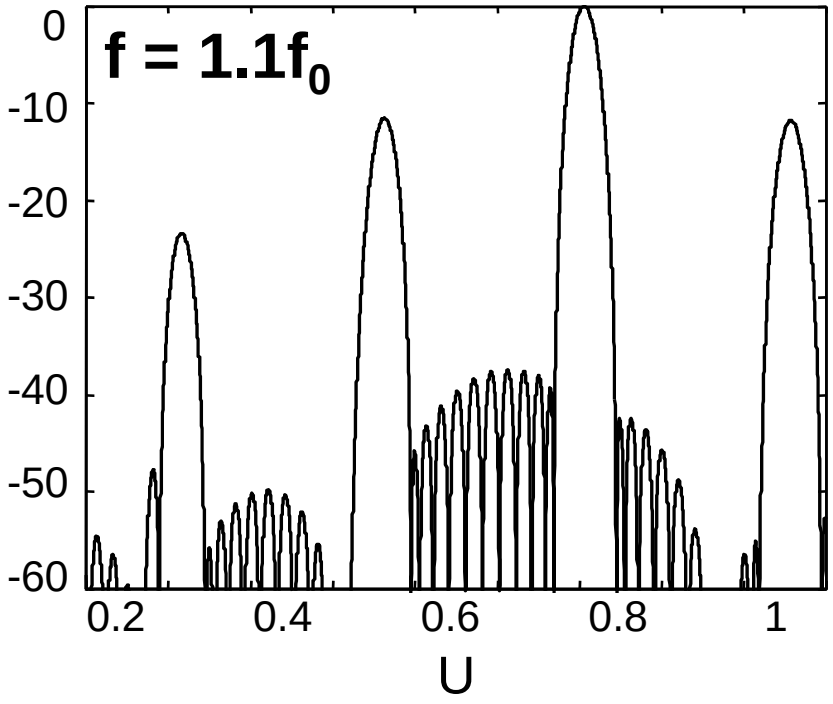
Outline

- Motivation
- Experiment
  - Experimental Setup
  - Parameter Optimization
  - Results
- Summary/Conclusions/Future Work

Contiguous Subarrays

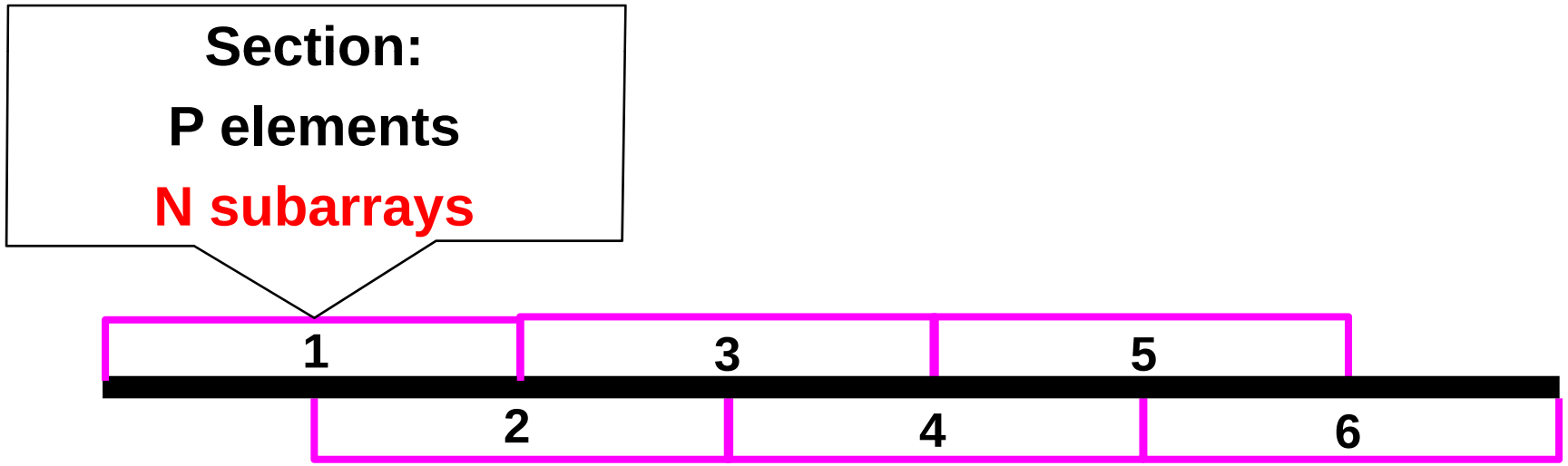






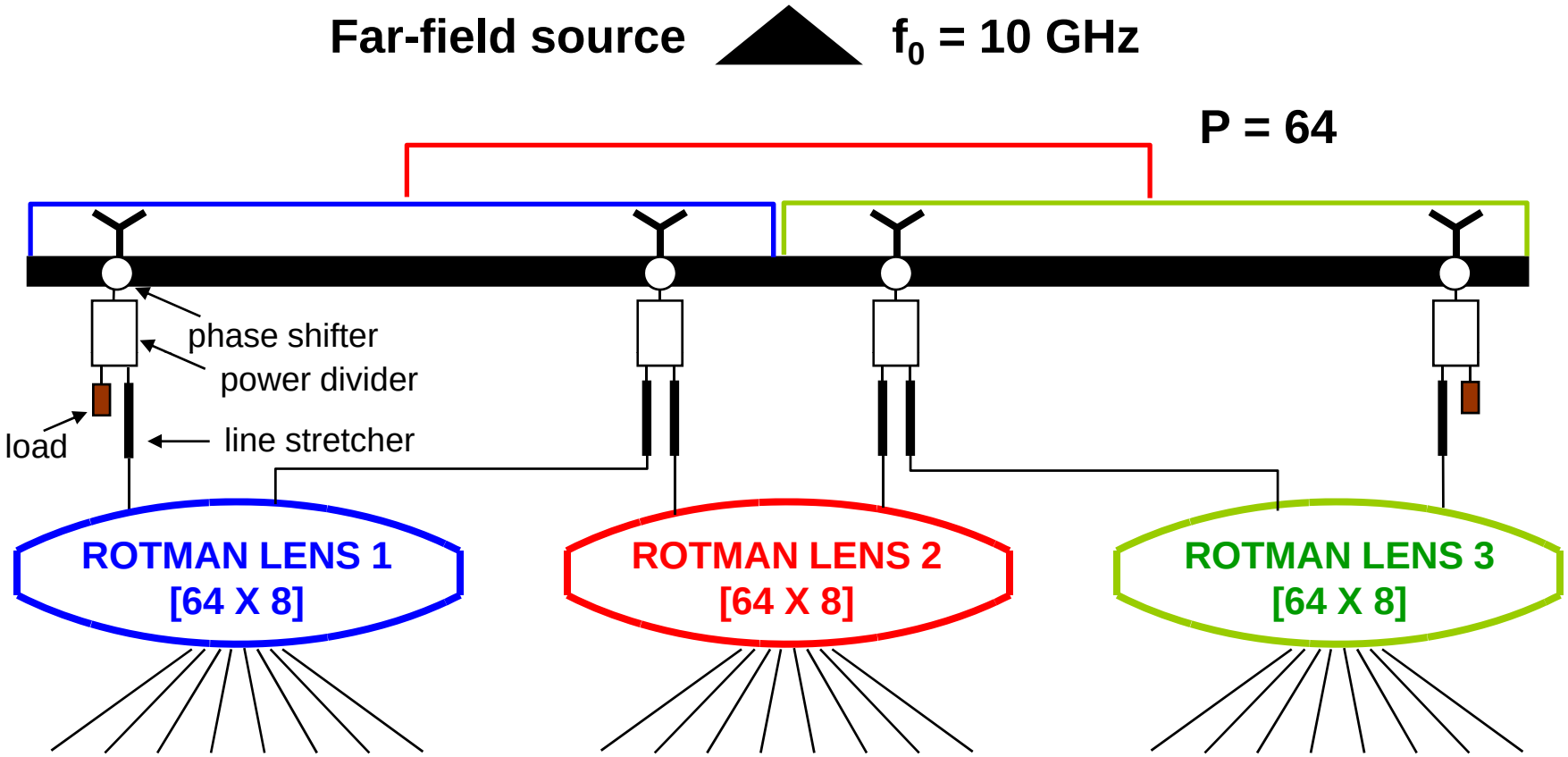
Partially Overlapped Constrained-Feed Network

Mailloux, R. J. (2001), "A Low-Sidelobe Partially Overlapped Constrained Feed Network for Time-Delayed Control," IEEE Transactions on Antennas and Propagation, Vol. 49, No. 2, February 2001.

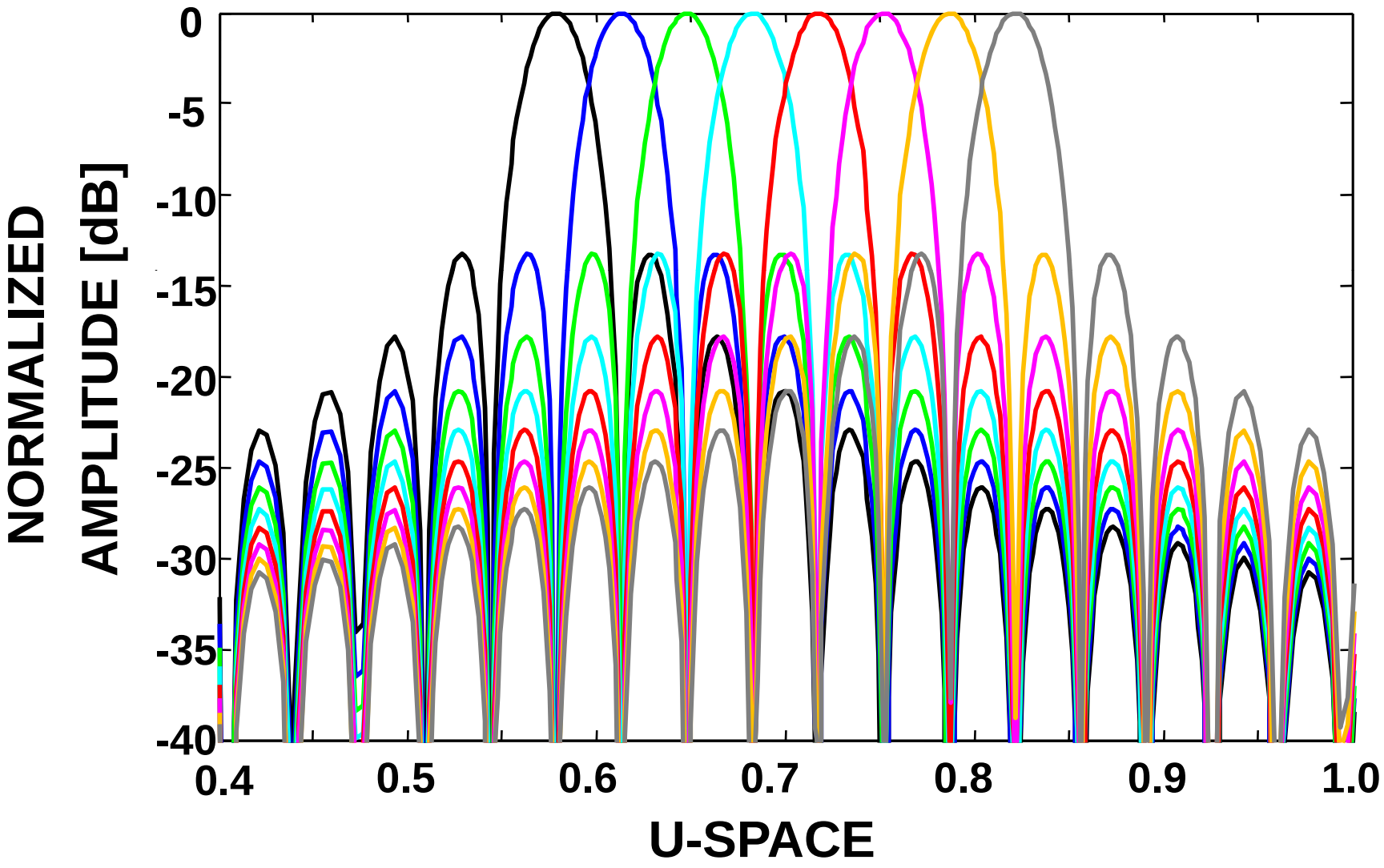


- **-30dB sidelobe levels over 20% bandwidth**
- **Design experiment to test theory**

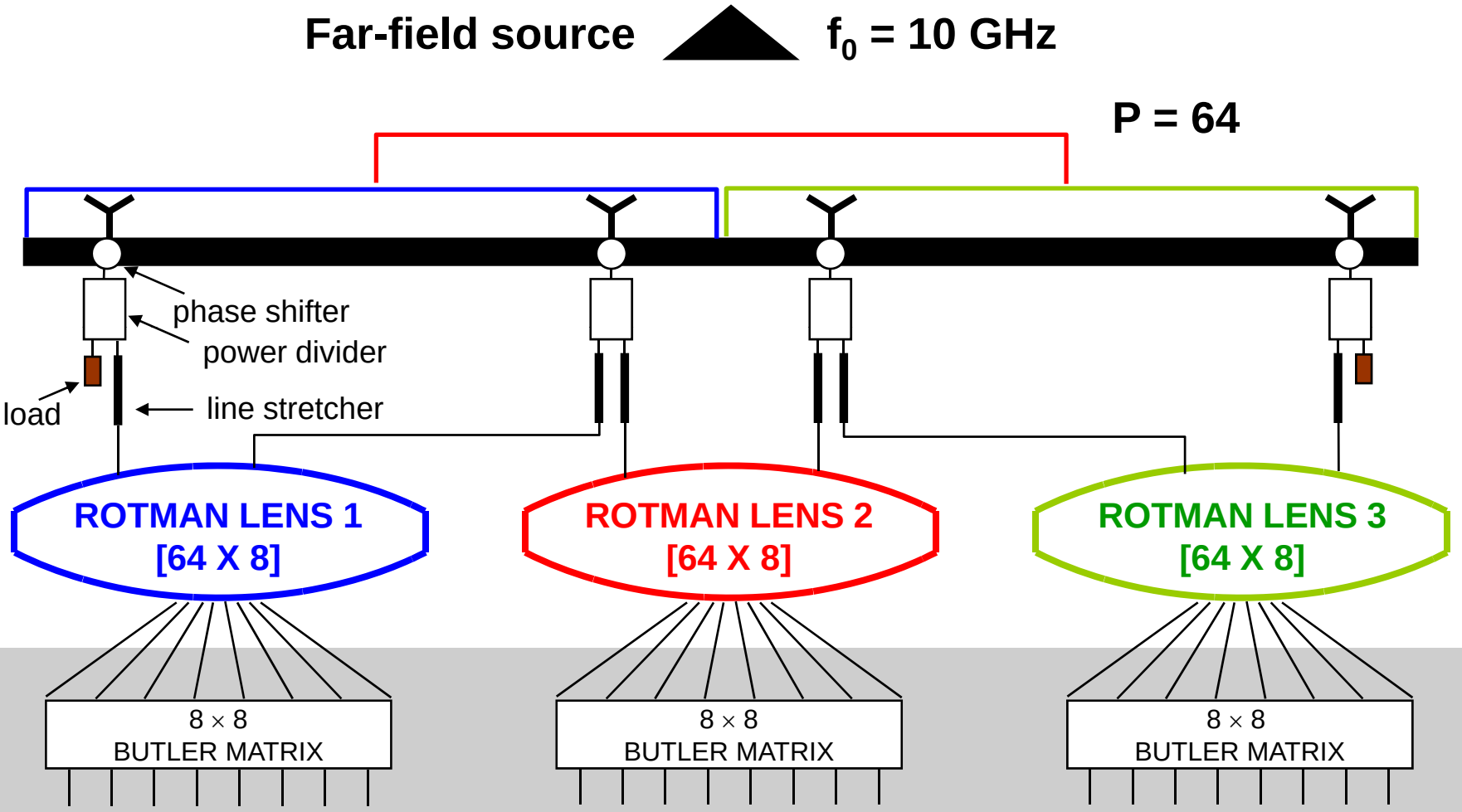
Experimental Block Diagram



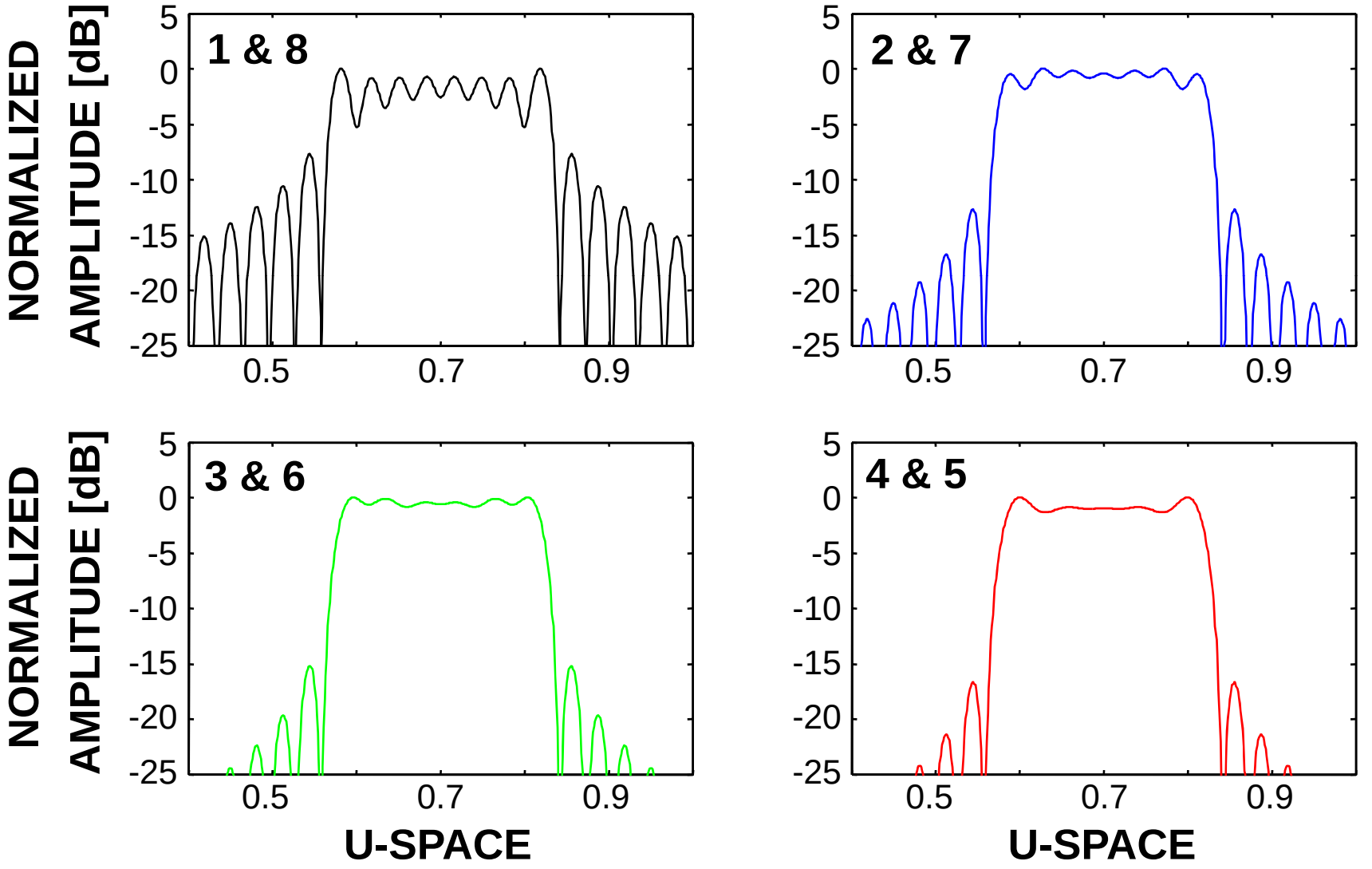
Constituent Beams



Experimental Block Diagram



Subarray Patterns

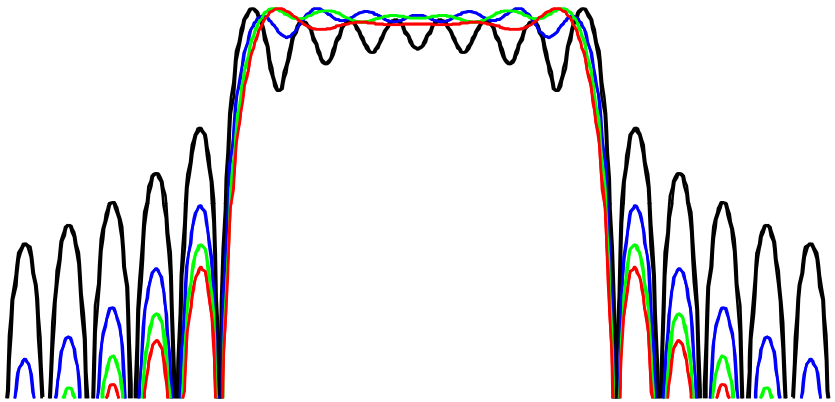


Analysis of a Single Section

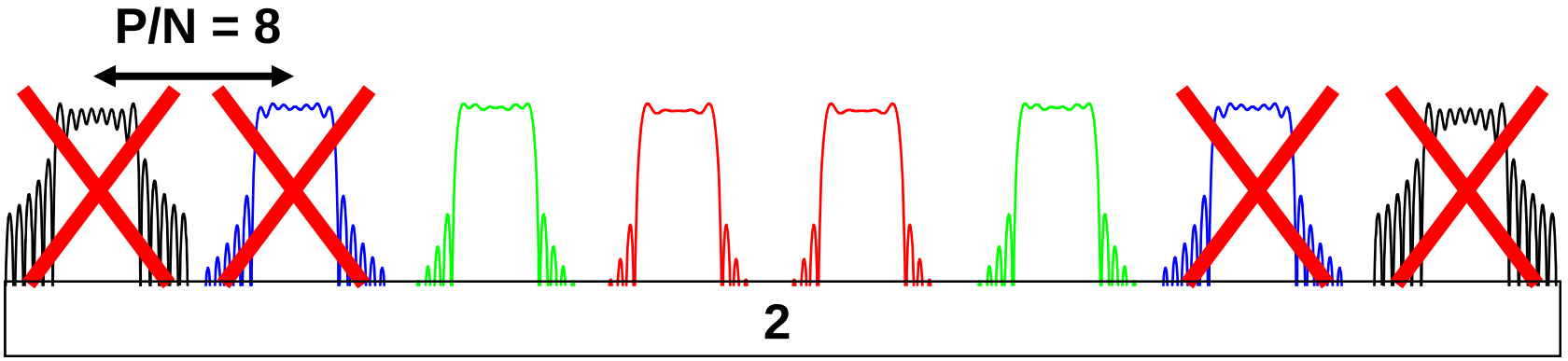
1	2	3

P = 64

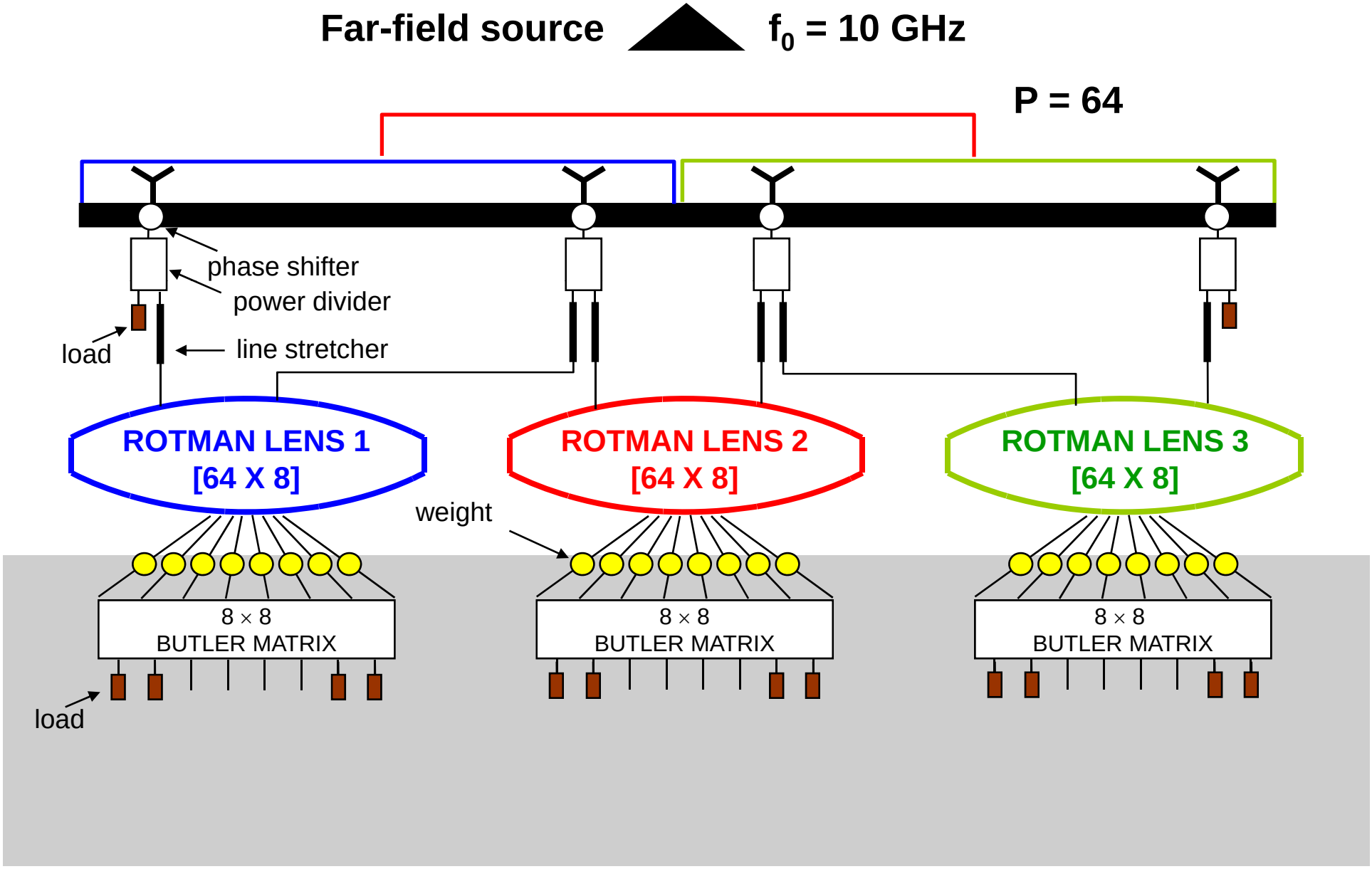
N = 8



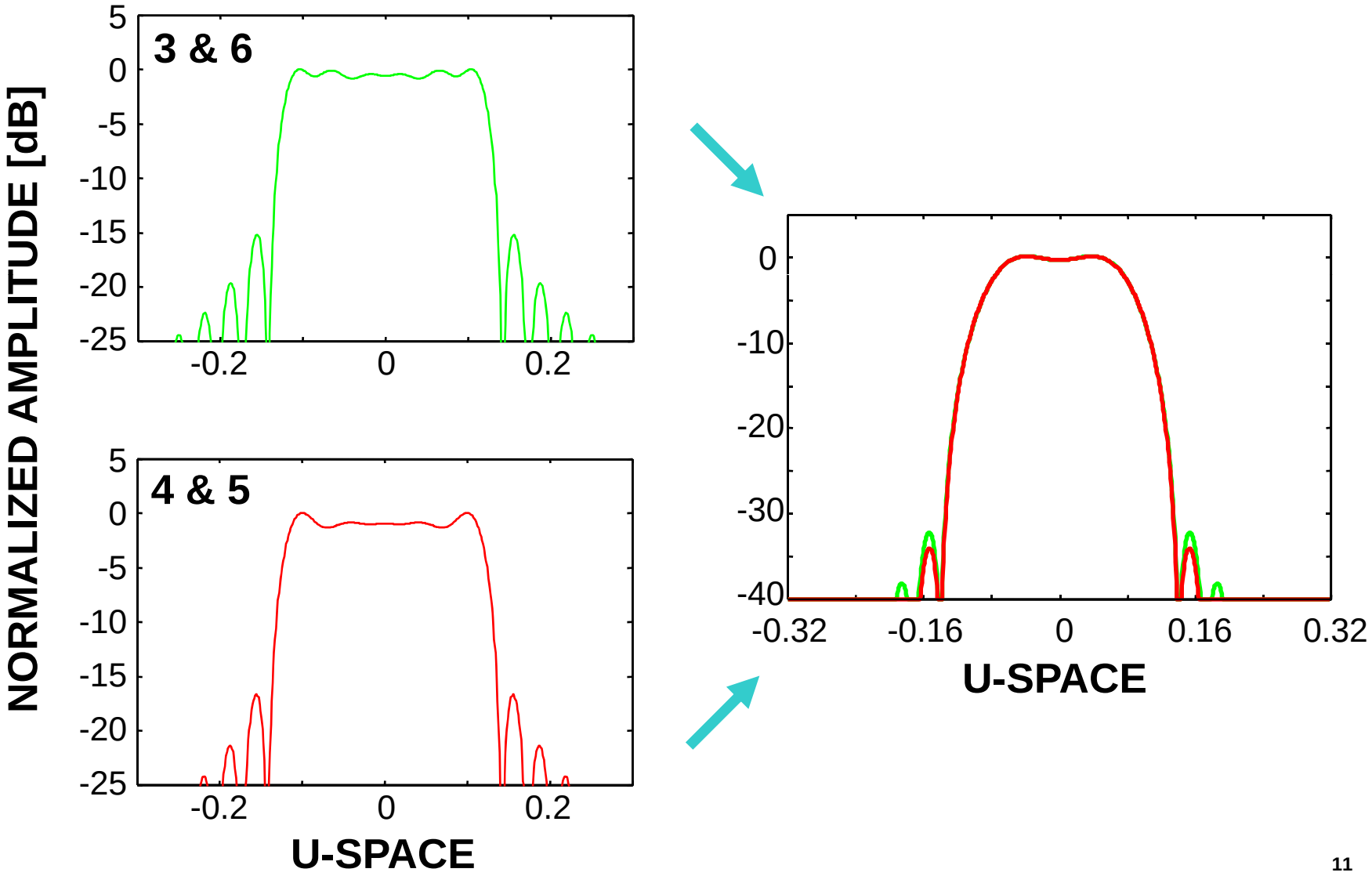
U-SPACE



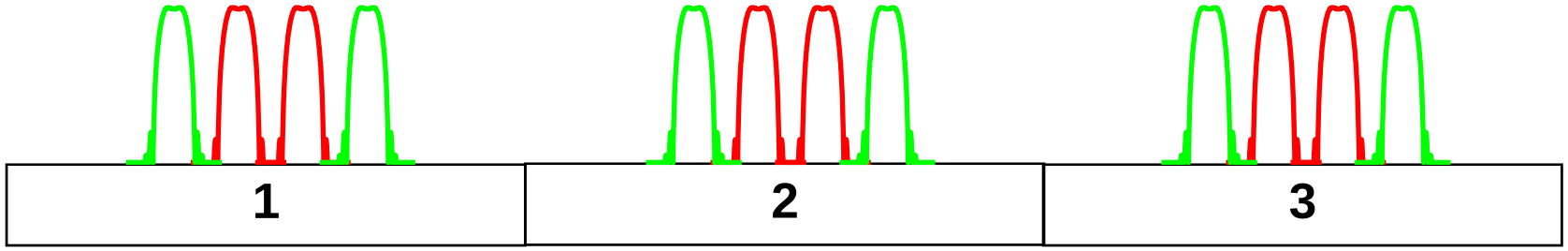
Experimental Block Diagram

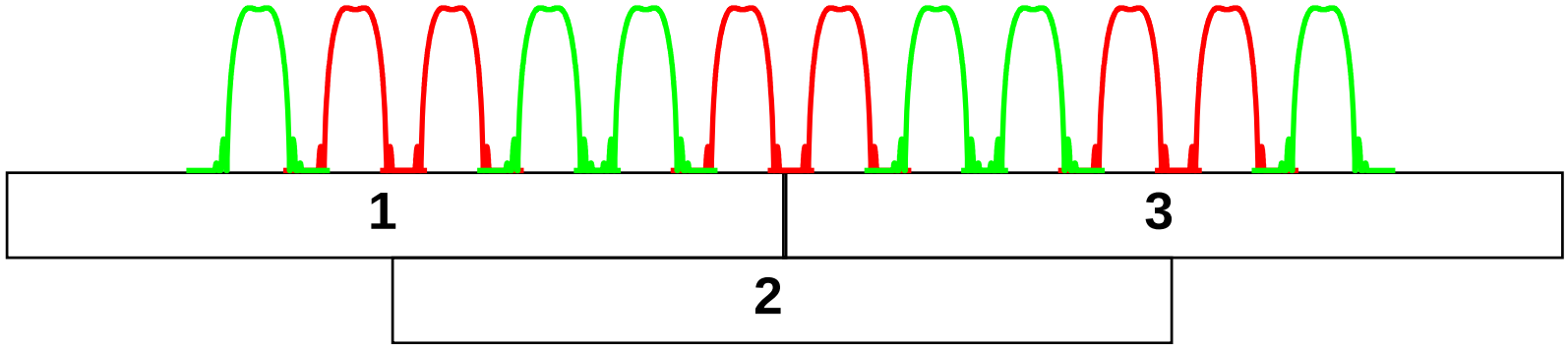


Constituent-Beam Weighting

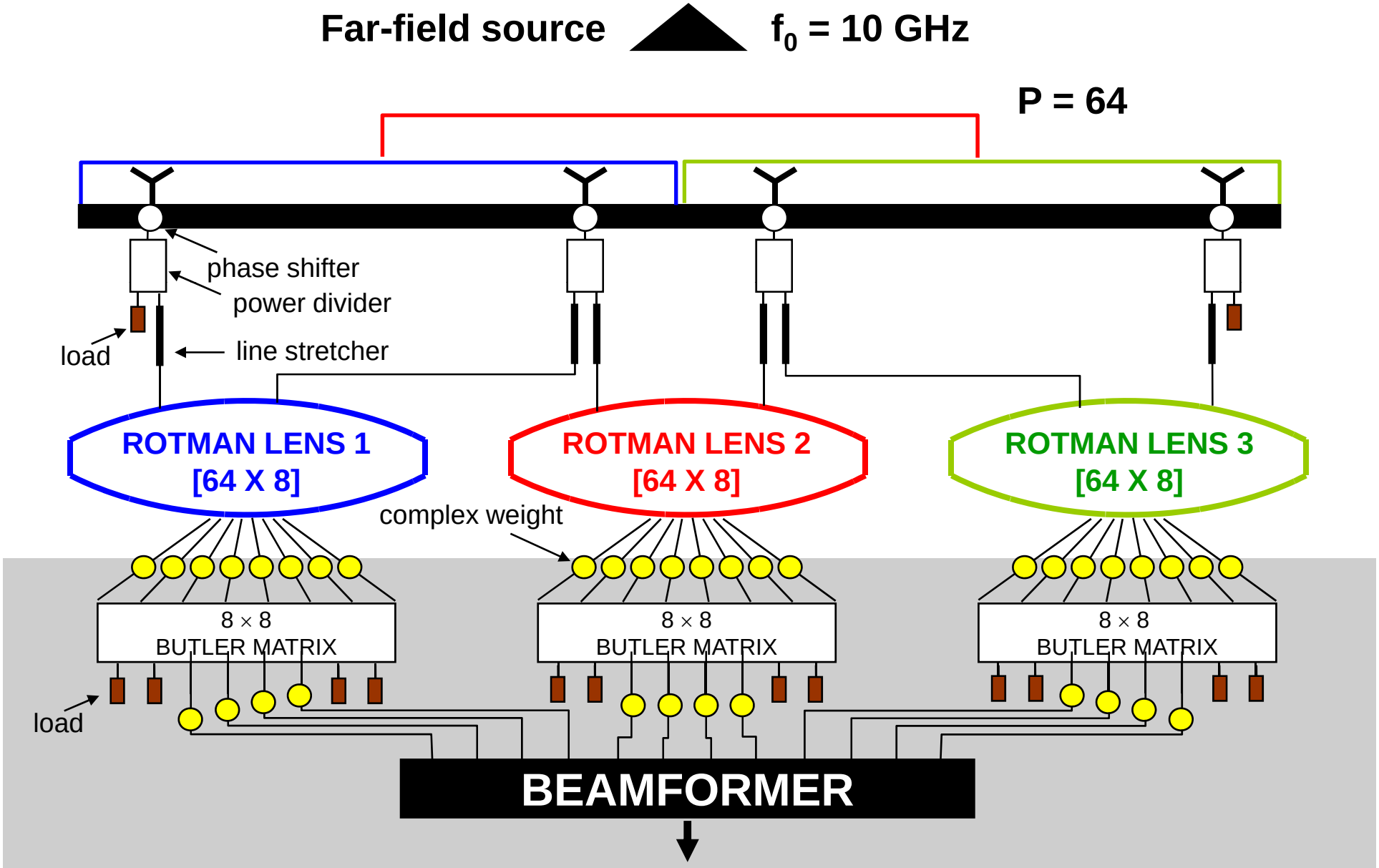


Partially Overlapped Sections

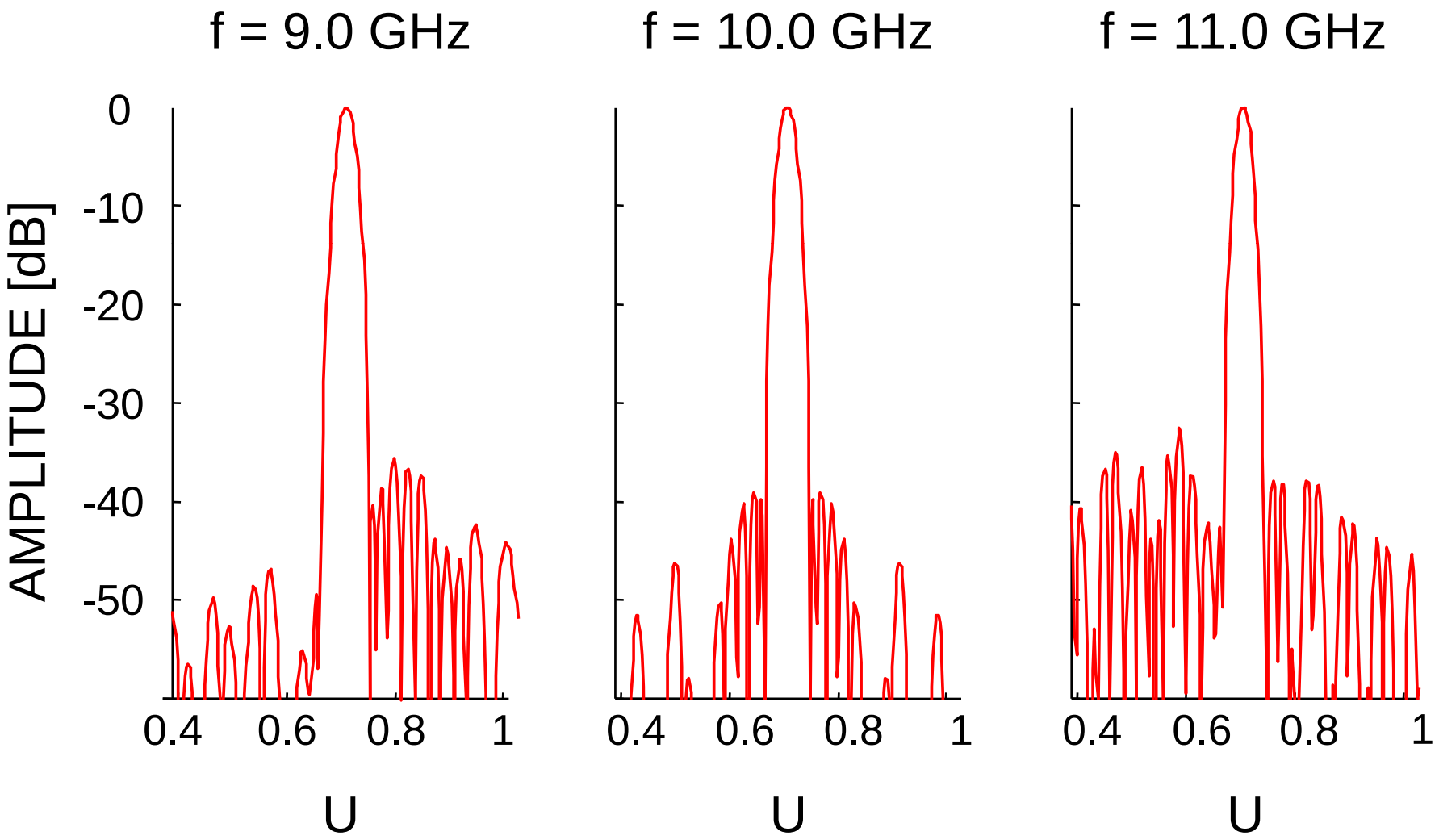




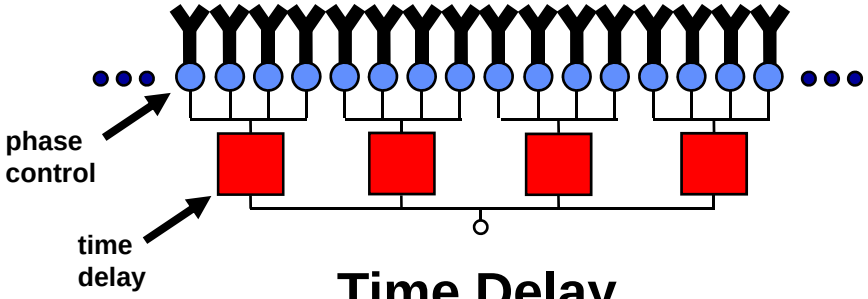
Experimental Block Diagram



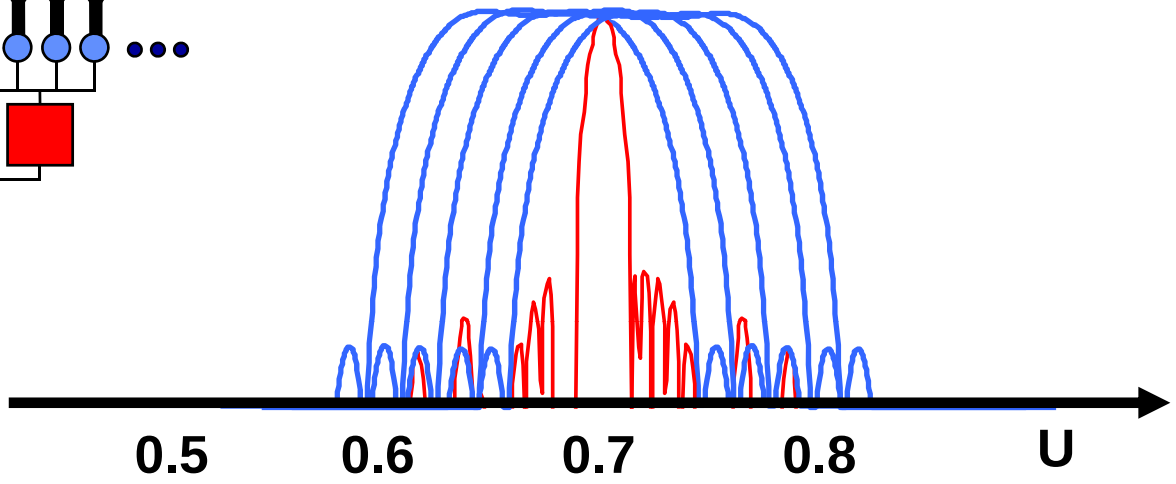
System Radiation Pattern (Ideal System)

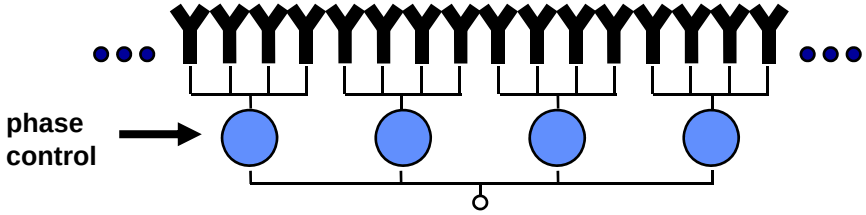


Time Delay vs. LFOV

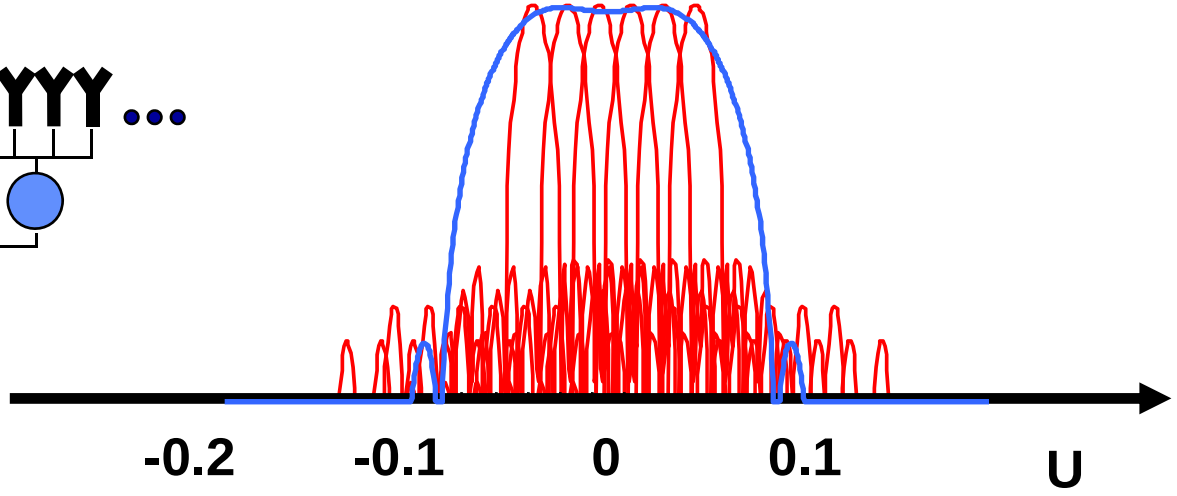


Time Delay



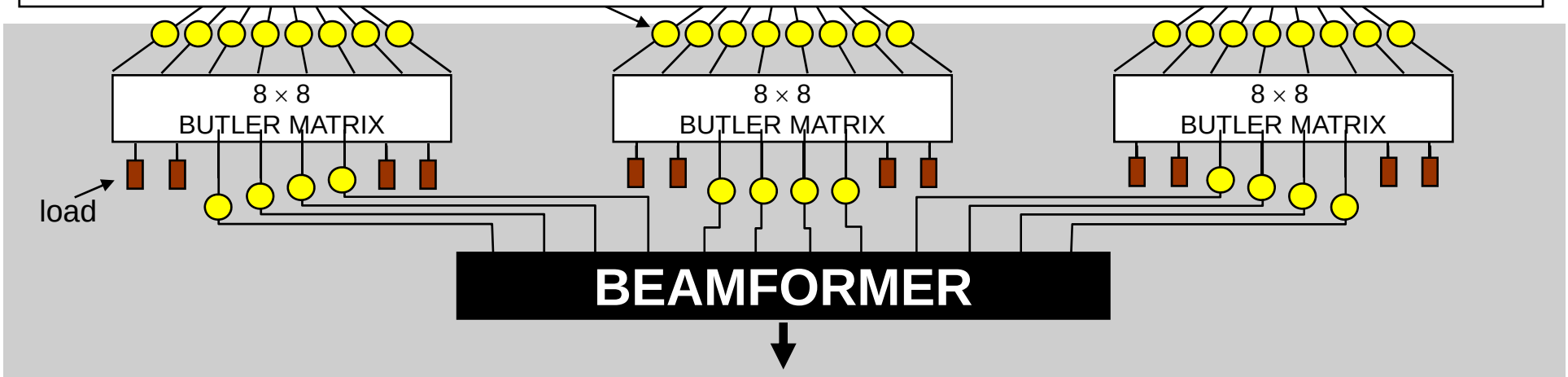


LFOV

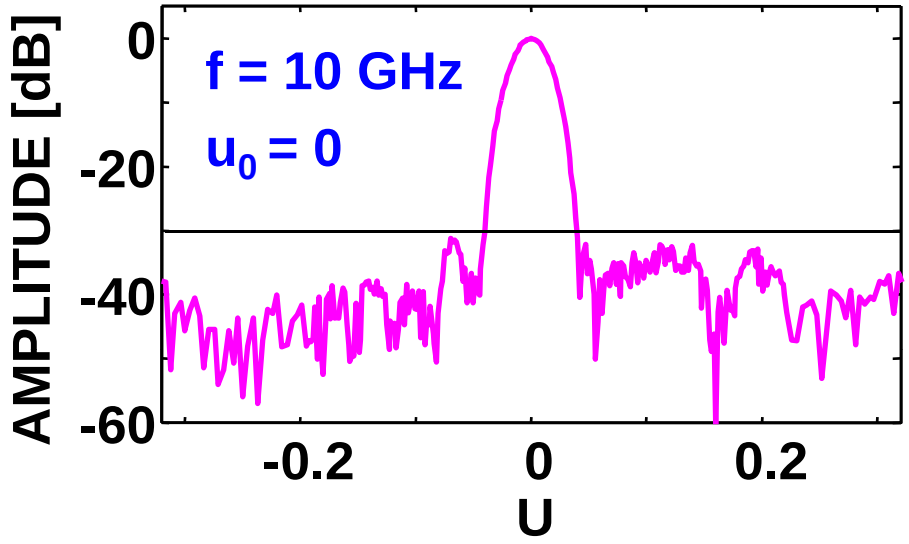


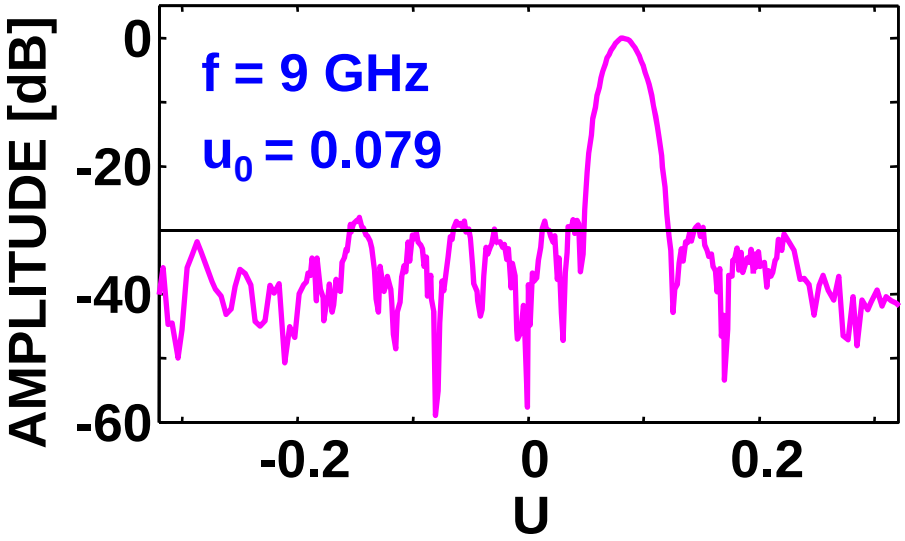
System Optimization

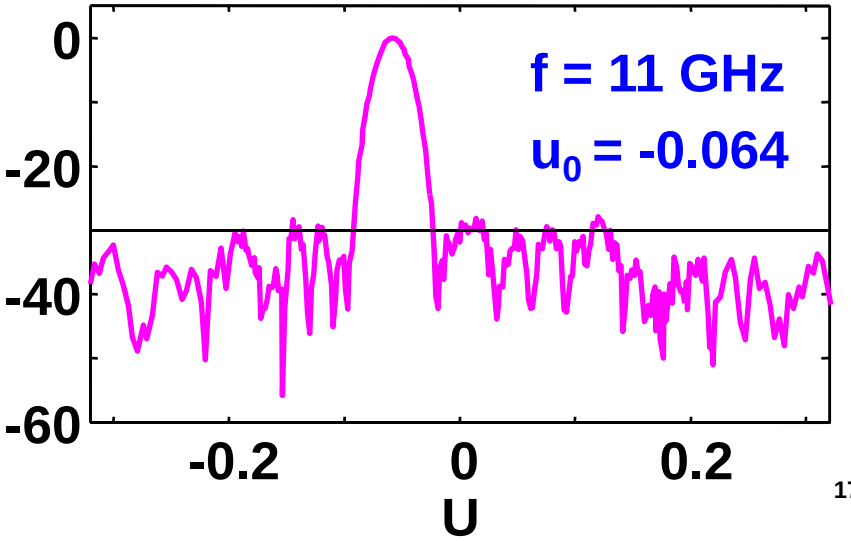
- Optimize weights for constituent beam and subarray ports
- Ideal System
  - Method of Alternating Projections (constituent beams)
  - 40-dB Taylor weighting (subarray ports)
- Experiment
  - Used genetic algorithm to optimize both sets of weights



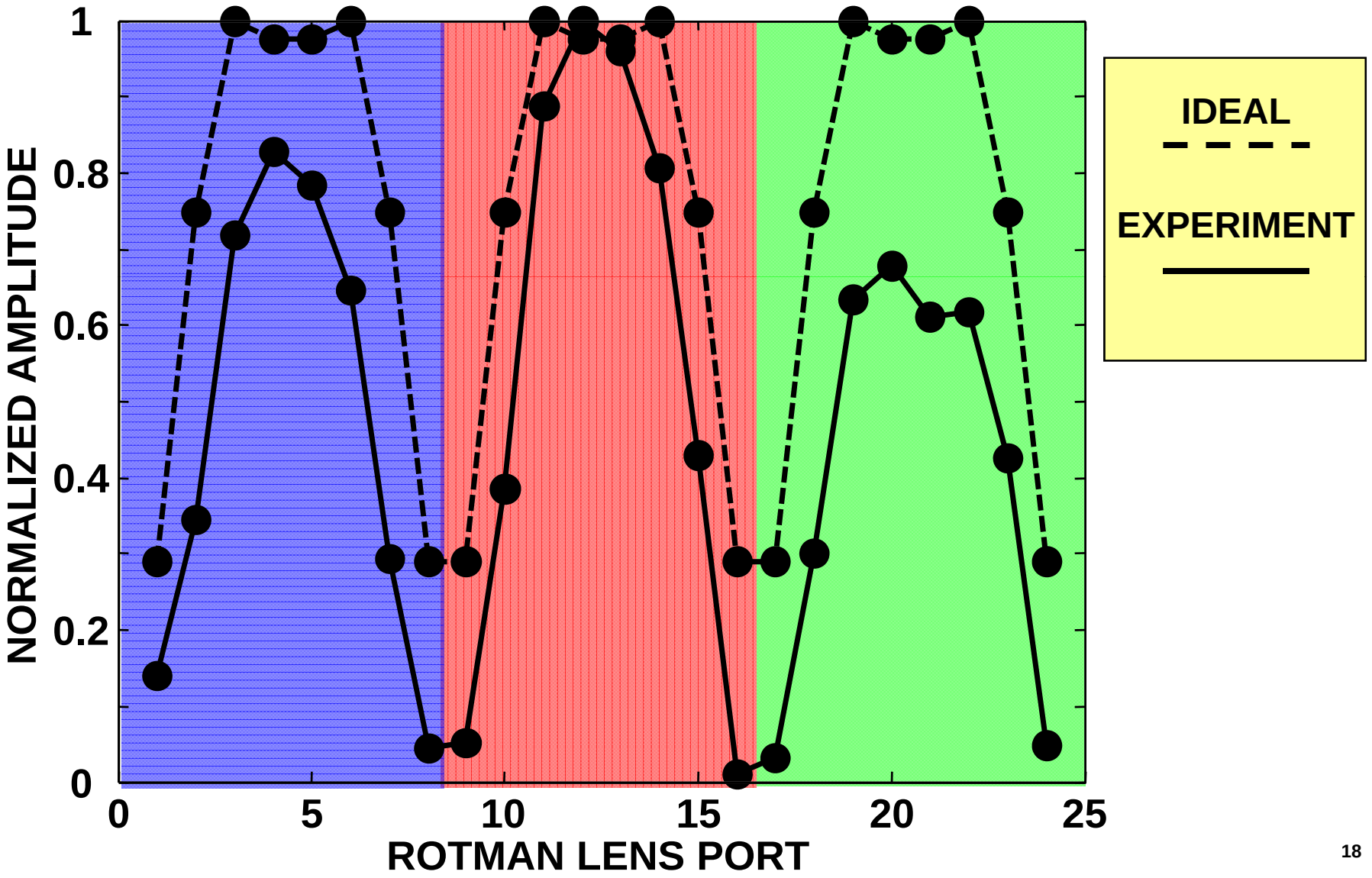
Results


AMPLITUDE [dB]
0
-20
-40
-60
f = 10 GHz
u_0 = 0
-0.2
0
0.2
U

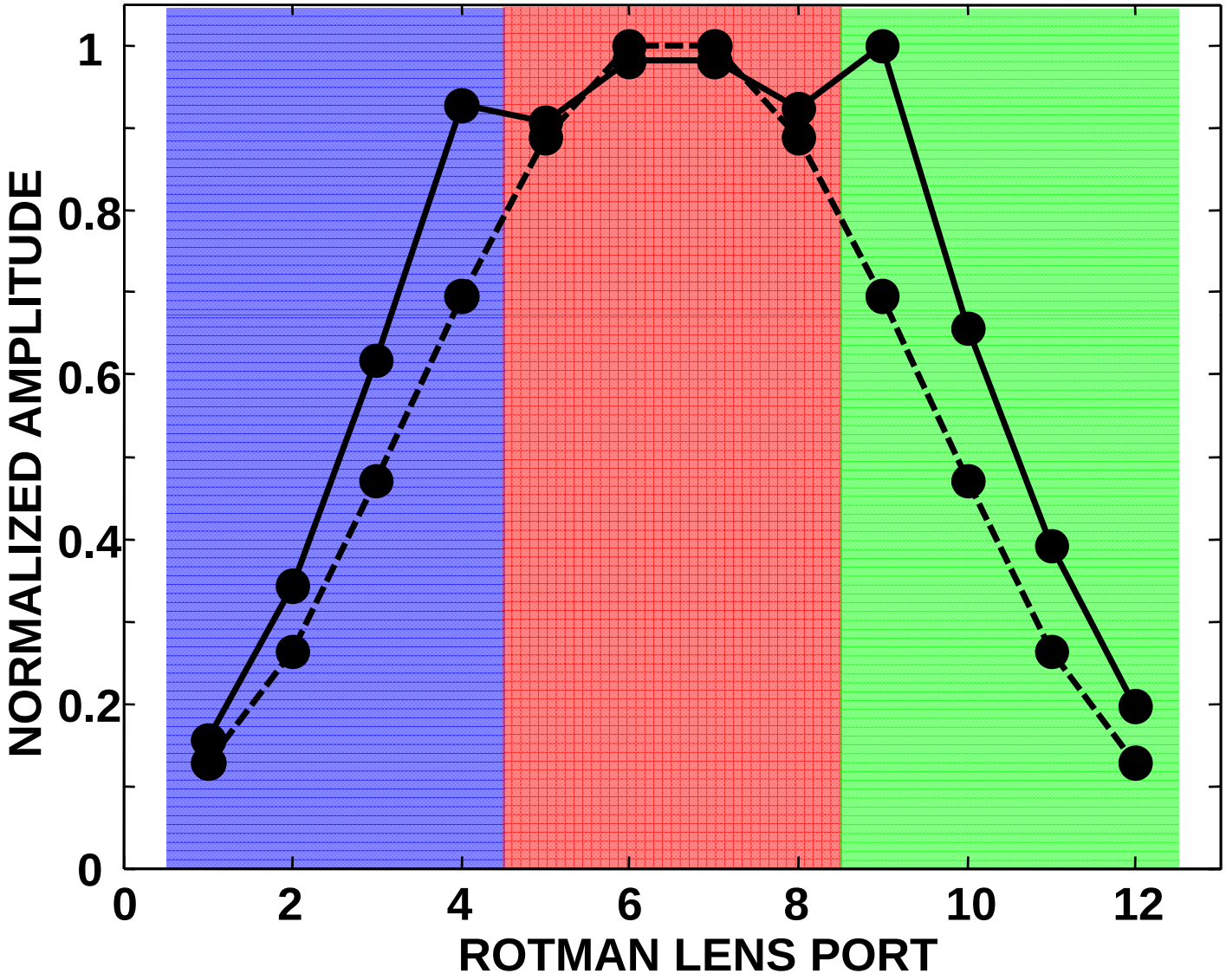

AMPLITUDE [dB]
0
-20
-40
-60
f = 9 GHz
u_0 = 0.079
-0.2
0
0.2
U


0
-20
-40
-60
f = 11 GHz
u_0 = -0.064
-0.2
0
0.2
U

Constituent-Beam Weights



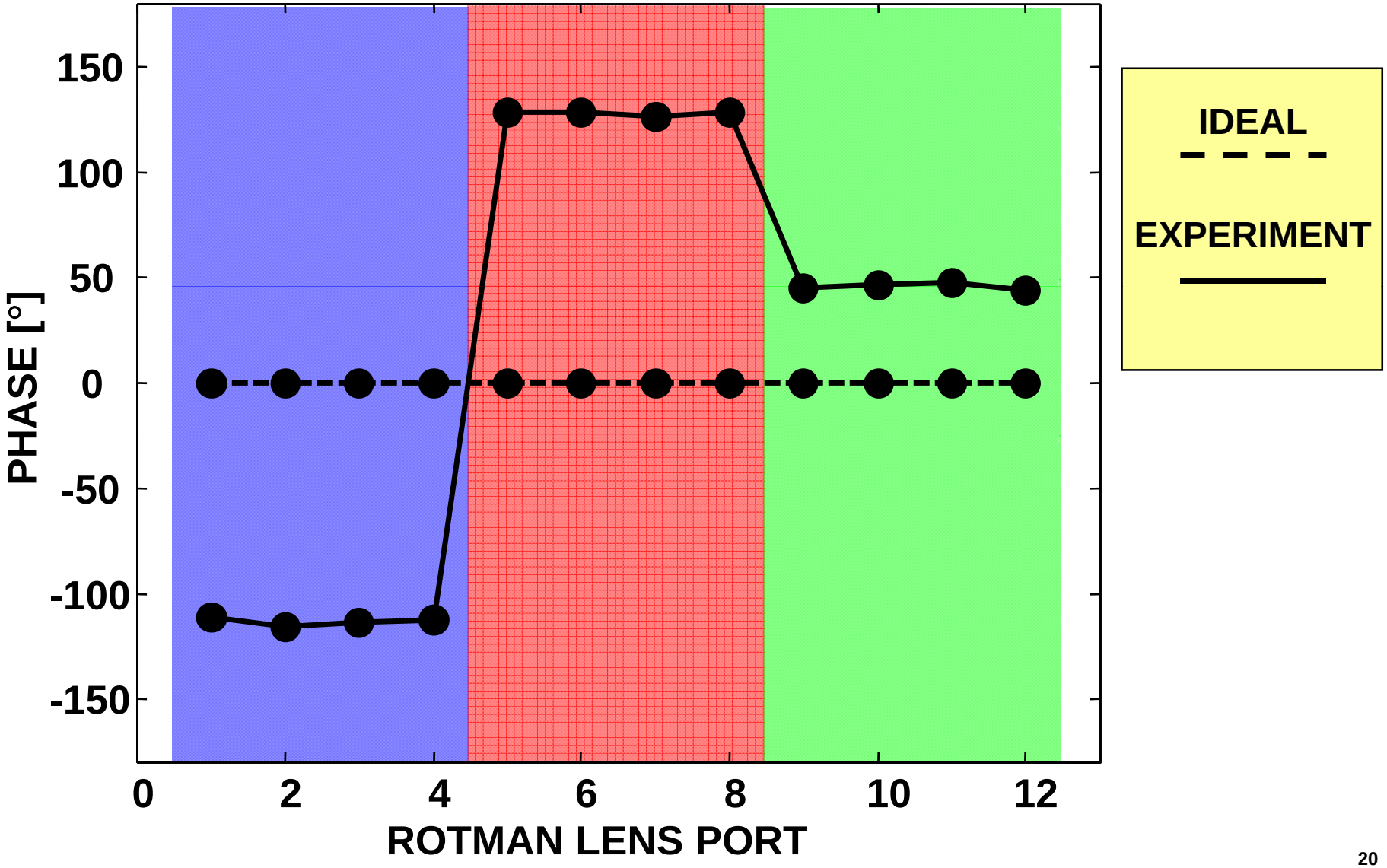
Subarray Weights



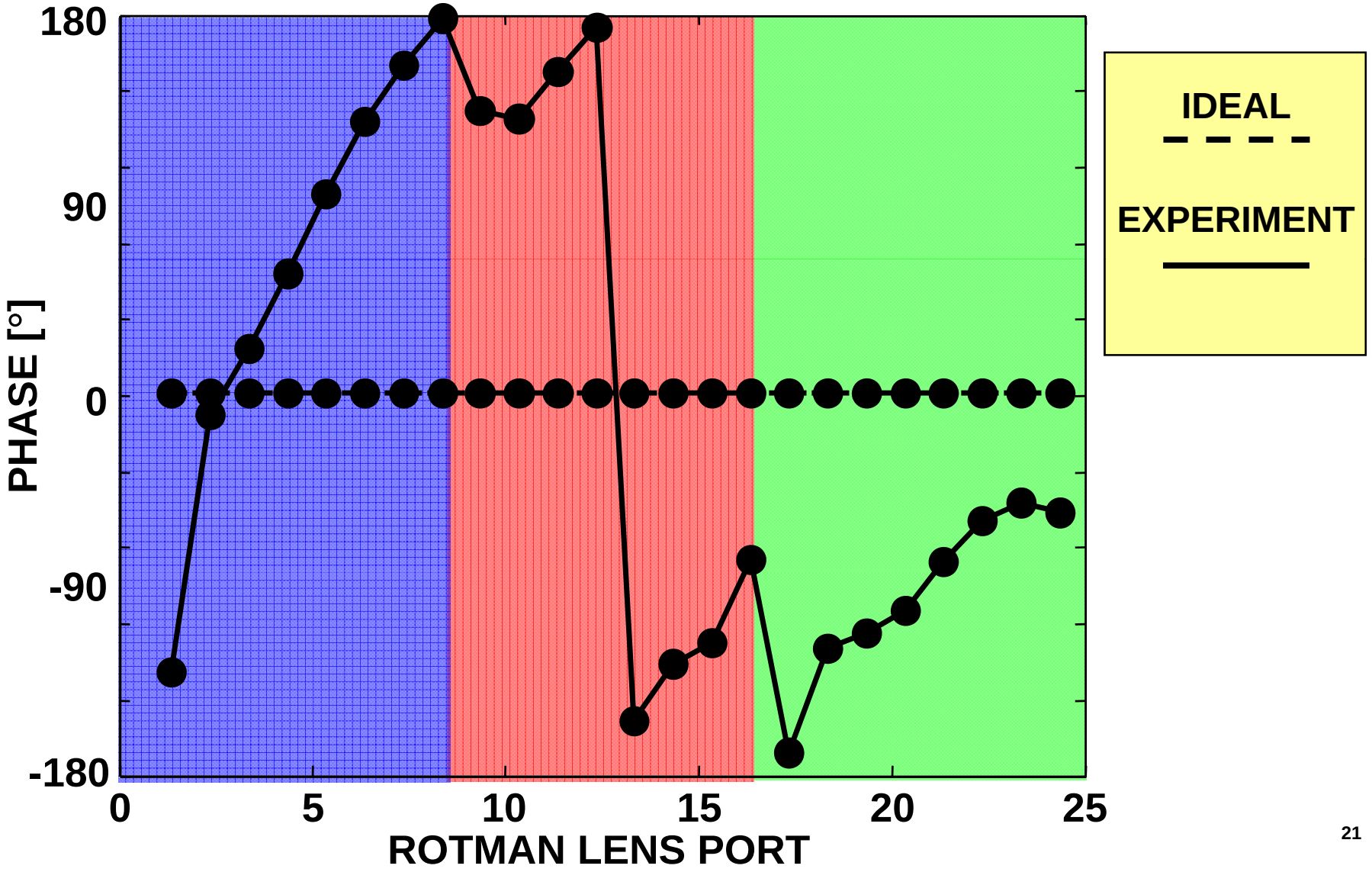
IDEAL

EXPERIMENT

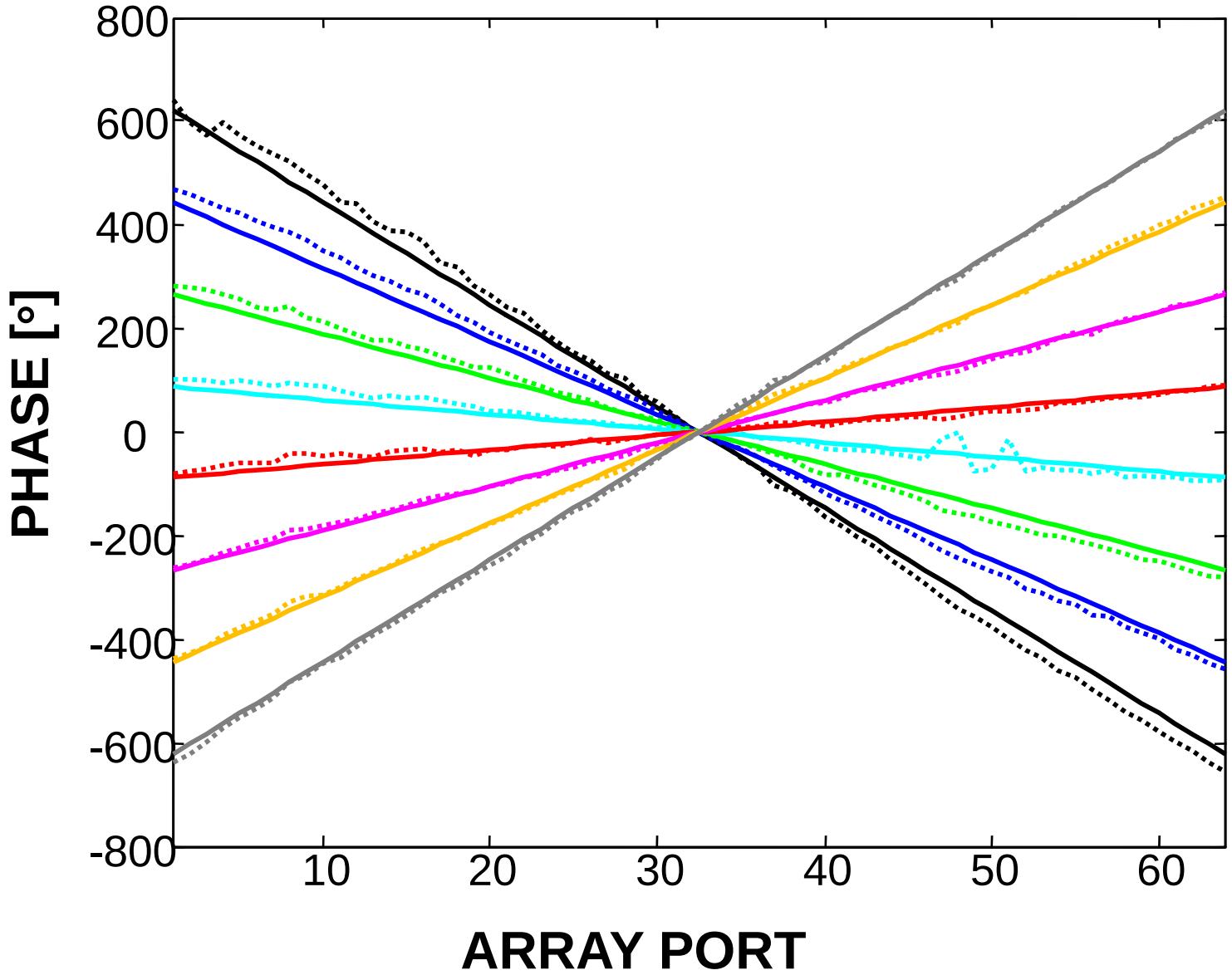
Subarray Weights (Phase)



Constituent-Beam Weights (Phase)



Rotman Lens Transfer Function: Phase



Conclusions/Future Work

- **Partially overlapped constrained-feed network:**
  - **Solves the quantization lobe problem associated with contiguous subarrays**
  - **Experiment demonstrated –30-dB sidelobes over a 20% bandwidth**
  - **Constrained nature allows for array expansion without increasing depth of system**
- **Future Work**
  - **Phase shifters at element level**
  - **Transfer function of entire system**